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Abundance and Distribution of Osprey Nest Sites in the Williston Reservoir Area, North-Central British Columbia 2002

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1.0 ABSTRACT

Helicopter surveys were conducted during April, June and September 2002 to investigate the abundance and distribution of osprey nest sites present in and around the Parsnip and Finlay Reaches of the Williston Reservoir. The number of gross (N_g = 112 to 134 nest sites) and occupied (N_o = 75 to 79) osprey nest sites, and clutch sizes (x = 2.36 to 2.65 eggs/occupied nest) remained relatively constant over the 3 survey periods (June 1995, June 1997 and June 2002), suggesting that the nesting population of ospreys is stable in the Williston Reservoir area. However, most (70%) of the gross and occupied nest sites that were identified in June 1997 were not present in June 2002. The majority (>85%) of gross and occupied nest sites lost between 1997 and 2002 were compensated for by new nest sites being built; only a small percentage of previously unoccupied nests were occupied on the subsequent survey. The location of gross and occupied nest sites, based on both their geographic and cross-sectional position in the reservoir, showed a shift in their position from June 1997 to June 2002. There appears to be a trend away from the Manson region and towards the Finlay region, and from the lower inundation zone to the upper inundation zone of the reservoir. The latter positional change is more likely an artefact of nest site availability in these two regions than a shift in osprey preference; in all 3 years, >80% of nest sites were located in the reservoir inundation zones. The reason for the geographic shift in nest site positioning is unknown, as there are no data for the availability of, or potential change in, food resources and suitable nesting sites (trees that would accommodate an osprey nest). The fate of nest sites lost between June 1997 and June 2002 was largely unknown as it was difficult to determine if a nest had fallen from a nest tree or if the nest tree itself had fallen. Full-pool reservoir water levels appear to have minimal direct impact on occupied osprey nest sites based on June to September 2002 data. A review of artificial nest site enhancements that have been conducted by other researchers was performed, with a summary of those findings and recommendations for potential nest site enhancement options in the Williston Reservoir watershed being presented.

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2.0 INTRODUCTION

The osprey (*Pandion haliaetus*) population in the Williston Reservoir watershed was examined in both 1995 and 1997 by the Peace/Williston Fish and Wildlife Compensation Program [PWFWCP] (Booth et al. 1999, Merkens et al. 1999). In 1995, three preliminary helicopter surveys were conducted to identify the population status and nesting habitat of both ospreys and bald eagles (*Haliaeetus leucocephalus*) adjacent to the Williston and Dinosaur Reservoirs. In March, prior to the breeding season, the first survey identified existing nest locations around the perimeters of the two reservoirs. Clutch sizes for both species were then recorded during a May survey, followed by a fledgling success survey for breeding pairs in July. In 1997, a more thorough and species-specific helicopter inventory was conducted around the Williston Reservoir and along its major tributary rivers. A winter survey was again conducted prior to the breeding season to identify nest locations, but separate species-specific surveys were conducted in the spring to identify occupancy and clutch sizes, and again in the summer to identify fledgling success. The 1997 surveys helped to describe nesting habitat of ospreys in both reservoir and riverine systems; facilitated an evaluation of the size, status, and productivity of the Williston osprey population; and provided a chance to compare the population density, productivity, and nest habitat use of ospreys residing adjacent to a reservoir and along major rivers in north-central British Columbia (see Merkens et al. 1999).

Although osprey productivity for the Williston Reservoir appeared to be well within the range of a stable population, results from those earlier surveys suggested that periodic surveys were warranted since most osprey nests were situated in dead trees in the inundation zone of the reservoir (Merkens et al. 1999): areas where nest tree retention could be a potential problem due to decay, wind, wave, and ice action. Accordingly, recommendations were also made regarding the development of an enhancement trial that would address or mitigate this future potential loss.

Based on the previous survey data, the PWFWCP decided that a survey return interval of 5 years should be sufficient to detect any significant declines – from the 1997 levels – in the abundance and distribution of nesting sites, and/or in the densities of ospreys breeding around the Williston Reservoir. Consequently, in 2002, two osprey surveys were repeated: a pre-breeding nest identification survey and a spring osprey occupancy survey. As a proactive measure, the PWFWCP also proposed that enhancement techniques (e.g., man-made nesting

structures) be developed and tested for their efficacy should they be needed in the future[1]. A survey of select nest sites was also opportunistically added in September to document the potential direct nest loss due to high water levels; the Williston Reservoir unexpectedly reached full pool in 2002.

The objectives of this report are to –

- re-assess the abundance and distribution of osprey nest sites around the Williston Reservoir (Parsnip and Finlay Reaches only);
- document osprey clutch sizes for 2002, and compare these data to 1995 and 1997 data;
- examine the nest attrition rates for two distinct time periods: 5 year (June 1997 to June 2002) and within year (April to June 2002);
- determine the direct impact of full-pool reservoir water levels on osprey nests situated at lower heights in the reservoir inundation zone (e.g., within 2 m of the full-pool water level); and
- present the most appropriate enhancement techniques that could be used to benefit ospreys in the Williston Reservoir watershed.

3.0 STUDY AREA

The study area encompassed the Parsnip and Finlay Reaches of the Williston Reservoir in north-central British Columbia (Figure 1); the Peace Reach was omitted as only a few nests were found during the previous surveys (Booth et al. 1999, Merkens et al. 1999). In 1968, the W.A.C. Bennett Dam was completed on the Peace River, resulting in the impoundment of the upper Peace River and the lower sections of the Finlay and Parsnip Rivers to form the Williston Reservoir, BC's largest body of fresh water. The reservoir has a surface area of 1,778 km^2, and a shoreline perimeter of 1,770 km (BC Hydro 1988). Several major river systems flow into the reservoir, draining an area of 69,930 km^2 (BC Hydro 1991).

[1] Planning for the enhancement trial was initiated but the field component was deferred because the 'best' nest site type and location could be identified based on the extensive literature review that had been conducted and the findings of this study.

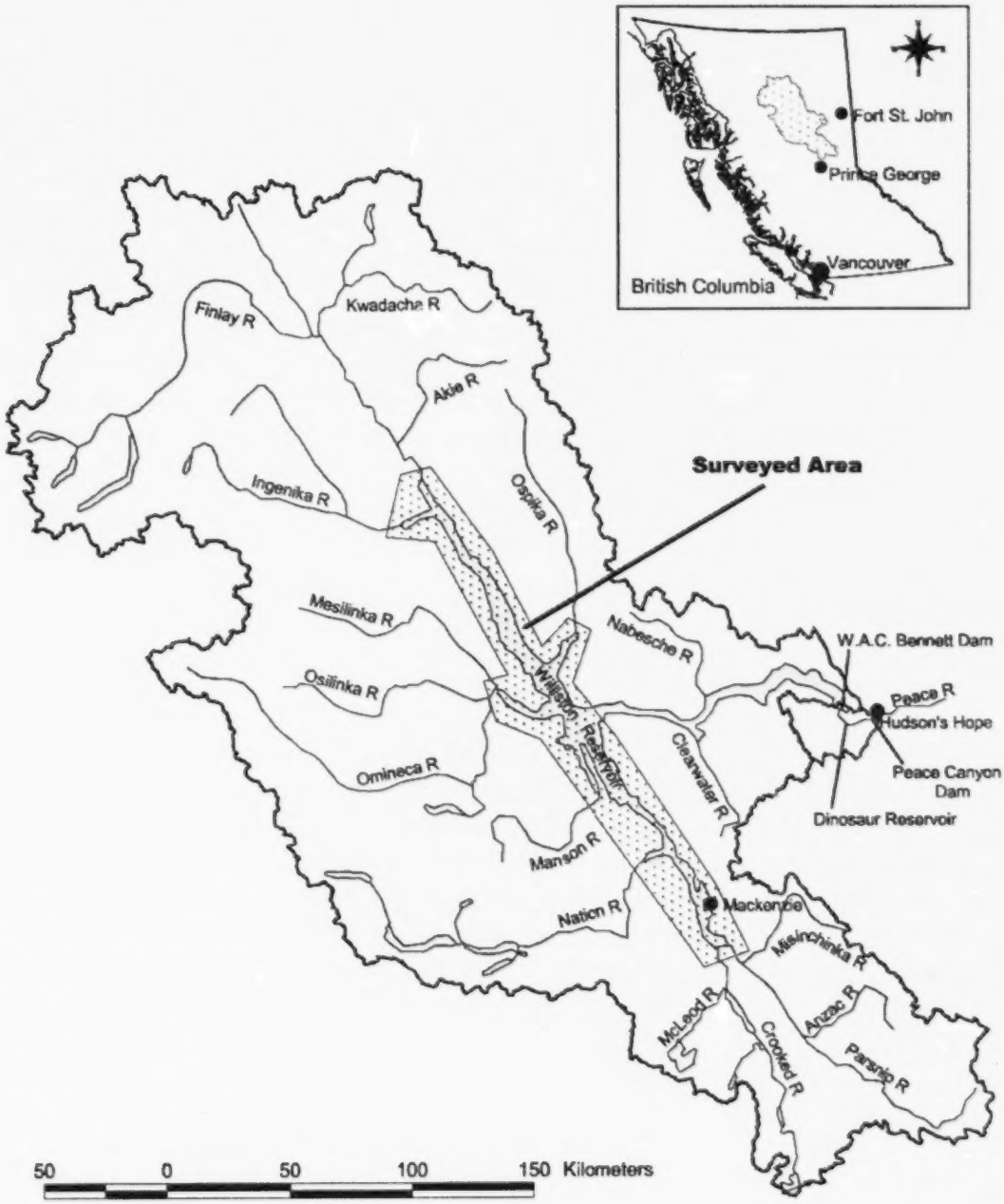


Figure 1. Area surveyed for osprey nest sites within the Parsnip and Finlay Reaches of the Williston Reservoir.

The majority of the study area lies within the Sub-Boreal Interior Ecoprovince, with only the northern tip of the Finlay Reach within the Boreal Mountains Ecoprovince (Demarchi 1995).The Williston Reservoir is surrounded predominantly by the Sub-Boreal Spruce (SBS) biogeoclimatic zone, which includes the moist cool (mk1 and mk2) and wet cool (wk2) variants (MacKinnon et al. 1990, Delong et al. 1993). The dry cool variant of the Boreal White and Black Spruce biogeoclimatic zone (BWBSdk1) occurs at the northern tip of the Finlay Reach (MacKinnon et al. 1990).

The major tree species found along the perimeter of the reservoir are hybrid white spruce (*Picea glauca x engelmannii*), black spruce (*Picea mariana*), lodgepole pine (*Pinus contorta*), trembling aspen (*Populus tremuloides*), and paper birch (*Betula papyrifera*), with small pockets of black cottonwood (*Populus trichocarpa*) typically at river and creek mouths. Since much of the landbase under the Williston Reservoir was not logged prior to flooding, standing snags are found along sections of its shoreline, and are common in many of its shallow bays. The topography adjacent to the Finlay and Parsnip Reaches of Williston Reservoir is gentle to moderately sloping, with some steeper exposed cutbanks.

The Williston Reservoir water level fluctuates on an annual basis with its specific water level dependent on the amount of spring and summer inflow and the demand for hydroelectric power generation. With the high demand for electricity and the low inflow of water in winter, the reservoir typically reaches its lowest level in April. Throughout the summer, the water level increases until it reaches its highest level for the year by as early as late July. Although the water license allows for water levels down to 642.15 m, the reservoir water level generally fluctuates between 655.32 m and 672.08 m (full pool), with levels fluctuating about 8 to 14 m in any given year (BC Hydro in prep). The Finlay and Parsnip Reaches usually freeze over by December, with ice break-up typically occurring in early May.

Forest harvesting is the primary industrial activity in the watershed, with the reservoir being used as a transportation corridor for timber. The reservoir receives low to moderate use by recreationalists. Several game and non-game fish species are present in the Williston Reservoir that may be potential prey for ospreys (see Merkens et al. 1999 for further details).

4.0 METHODS

4.1 SURVEY METHODS

Using a Bell 206 Jet Ranger helicopter, 3-person crews conducted the nest identification survey in April and the occupancy and nest susceptibility surveys in June and September 2002. All surveys commenced about two hours after sunrise and ended at least one hour before dark. The person in the front seat of the helicopter was responsible for navigating, searching for nest sites, counting eggs and adults, and taking photographs and location coordinates of each nest site. In addition to searching for nest sites and counting adults and eggs, the rear seat observers also recorded data pertaining to the nest site, eggs or birds seen, and photographs taken. Depending on the shoreline habitat and ease of sightability, surveys were flown (speeds ranging from 130-160 km/hr) along the forest-reservoir interface at 60-120 m above the ground so that observers could search for nests within the reservoir inundation area and up to approximately 300 m inland.

Survey 1 (nest identification) was conducted on 18 and 19 April, 2002, and took approximately 15.5 hrs to complete, including ferry time. During this survey, attempts were made to re-locate each of the nest sites that were found along the Parsnip and Finlay Reaches during the 1995 and 1997 surveys; this included both osprey and eagle nest sites but only potential osprey nest sites are presented and used for any analyses. All new nest sites were also documented. When a nest site was located, the following data were recorded: nest site position coordinates, nest and tree characteristics, structural status of nest (e.g., good, falling apart), and description of surrounding habitat. Universal transverse mercator (UTM) coordinates for each nest site were obtained using a Garmin Etrex Summit Global Positioning System (GPS) unit (NAD83 datum); location coordinates were later downloaded and transferred into the survey database. A photograph was also taken of each nest site.

Survey 2[2] (occupancy) was conducted on 20 and 21 June, 2002, and took 12.2 hours of helicopter time to complete. All Survey 1 osprey nest sites were revisited, and nest occupancy and clutch size data were collected. Any new nest sites were documented as per Survey 1. In addition, the number and behaviour of adults present, number of eggs or chicks present, extent that nest trees were leaning, and estimated height of nest above ground or water were collected for all nests. Two photographs of each nest site were taken to facilitate

[2] The occupancy survey in 2002 was conducted 7-14 days later than recommended by Merkens et al. (1999) as the north-central interior of British Columbia experienced a later than normal start to spring and anecdotal breeding bird activity in the Prince George and Mackenzie areas indicated that birds were nesting at least one week later than normal.

the comparison of nest sites between surveys (both between and within years). Photographs were taken of each nest tree (close-up) and its surrounding area (distant).

Survey 3 (susceptible nests) was conducted on 6 September, 2002, taking 3.0 hrs of flying time to complete. The primary purpose of the survey was to revisit a subset of nests that were deemed potentially vulnerable to being lost due to full-pool reservoir water levels (i.e., nests estimated to be within about 2 m of full-pool water levels). Nests were visually assessed for their structural integrity and for the distance between the bottom of the nest and the water surface. Reservoir water levels for all survey dates are presented in Table 1.

Table 1. Williston Reservoir water levels for each survey period, 1995 to 2002 (BC Hydro, unpublished data). Water level readings were taken at 24:00 hrs for each date. Full-pool water level is 672.08 m[a].

Year	Survey dates	Reservoir water level[b]	Difference from prior survey
1995	February 28-March 2	660.25 m	
	June 1-2	664.72 m	4.47 m
1997	June 10-11	663.80 m	
2002	April 18-19	658.42 m	
	June 20- 21	668.84 m	10.42 m
	September 6	671.29 m	2.45 m

[a] Reservoir water levels were at, or within 10 cm, of full pool from 11 Jul to 28 Jul 2002, and were within about 0.5 m of full pool from 06 Jul to 26 Aug 2002.

[b] Average water level for the survey period.

4.2 DATA SUMMARY AND ANALYSES

4.2.1 Nest status and nest site position nomenclature

The gross number of osprey nest sites included any nests that were considered to be a potential nest site for ospreys (e.g., large stick nests located on the top of a snag or tree). Nest status follows terminology used by Postupalsky (1974). An 'occupied' nest site was one that was attended by 2 adult ospreys early in the season, or that showed other obvious evidence of occupancy (e.g., eggs or young present).

For distribution analyses, nest sites were grouped into one of five different broad geographic regions within the surveyed area, based on the reach or arm of the Williston Reservoir: Parsnip, Manson, Omineca, Ospika, and Finlay (Table 2, Figure 2). These regions included the inundated portion of the reservoir and the upland habitat bordering their respective waterbody. The Manson region, however, also included the eastern portion of the Omineca Arm (east of Black Canyon) as it was felt that, due to their similarity in site characteristics (e.g., shallow bays and many snags) and close proximity to one another, the latter area was more similar to the Manson Arm proper than to the remaining portion of the Omineca Arm.

Within each region, nest sites were also categorised by their position within the cross-sectional profile of the area. Nest sites were placed within one of seven positions: lower inundation zone, upper inundation zone, upland, upland shoreline, wetland inundated lower, wetland inundated upper, and wetland natural (Table 3).

4.2.2 Nest site attrition and gain

In order to obtain a defendable estimate of the fate of nest sites, only those nests located during the 1997 and 2002 surveys were used for analysing nest attrition and gain. Along with their location coordinates, photographs of nest sites were used to determine if the same nest site was present at each survey period. The 1995 nest sites did not have adequate photographic evidence, and their GPS locations were not always sufficiently accurate to assist in a positive identification. In comparing nest sites from 2002 to 1997, a nest site was not considered to be the same site unless it was positively identified (i.e., the nest was in the same position in the same nest tree). A nest site was assigned one of five different classifications to delineate its fate since the previous survey (Table 4).

To determine the nest site attrition (loss of nest sites between survey periods) for each region, the number of nests within each region were compared between June 1997 and June 2002. Similarly, the within-year nest site attrition was based on nest sites from April and June 2002. In each case, frequencies were calculated for both the gross and occupied nests. The 5-year and within-year nest site gains were also calculated to assist in determining the overall and regional net gain or loss of gross and occupied nests.

Table 2. Delineation of geographic regions within the Finlay and Parsnip Reaches of the Williston Reservoir.

Geographic region	Operational definition
Parsnip	Entire perimeter of the Parsnip Reach (including the Nation Arm) from the Pack and Parsnip Rivers north to Finlay Bay and the northern tip of the Manson peninsula.
Manson	Entire perimeter of the Manson Arm, and the western shore of the reservoir from Fries Creek to Black Canyon and the northern shore from Black Canyon to the main point of land south of Raspberry Harbour.
Omineca	Entire perimeter of the Omineca Arm that is situated west of Black Canyon.
Ospika	Eastern shore of the reservoir from Andy Creek (north side of Finlay Forks) north to the point of land south of Mount Moodie (includes entire Ospika Arm).
Finlay	Entire perimeter of the Finlay Reach (including the Ingenika Arm) from the points of land south of Raspberry Harbour (west) and Mount Moodie (east) north to the Finlay River.

Table 3. Delineation of nest site positions based on the cross-sectional profile of the survey area, Finlay and Parsnip Reaches, Williston Reservoir.

Position	Operational definition of nest site position
Inundation zone - lower [IZL]	Lower foreshore and main reservoir area (approx. <668 m) that is usually always flooded, or for extended time periods every year; typically no or very little vegetation present.
Inundation zone - upper [IZU]	Upper foreshore (approx. 668-674 m) of reservoir that is only occasionally influenced by higher water levels; typically grass and shrub vegetation present, and often stands of dead trees)
Upland [U]	Forested areas >50 m (approx.) from upper inundation zone and not influenced by reservoir water levels
Upland shoreline [US]	Forested areas ≤50 m (approx.) from upper inundation zone and not influenced by reservoir water levels.
Wetland - inundated lower [WIL]	A low-lying area (natural wetland or forested area prior to reservoir creation) that is not directly connected to the reservoir but is influenced by reservoir water levels (i.e., ground water influence). Base of nest tree is submerged at all times, or at least for an extended period each year.
Wetland - inundated upper [WIU]	A low-lying area (natural wetland or forested area prior to reservoir creation) that is not directly connected to the reservoir but is influenced by reservoir water levels (i.e., ground water influence). Base of nest tree is occasionally influenced by reservoir water levels.
Wetland - natural [WN]	A natural wetland not affected by reservoir water levels.

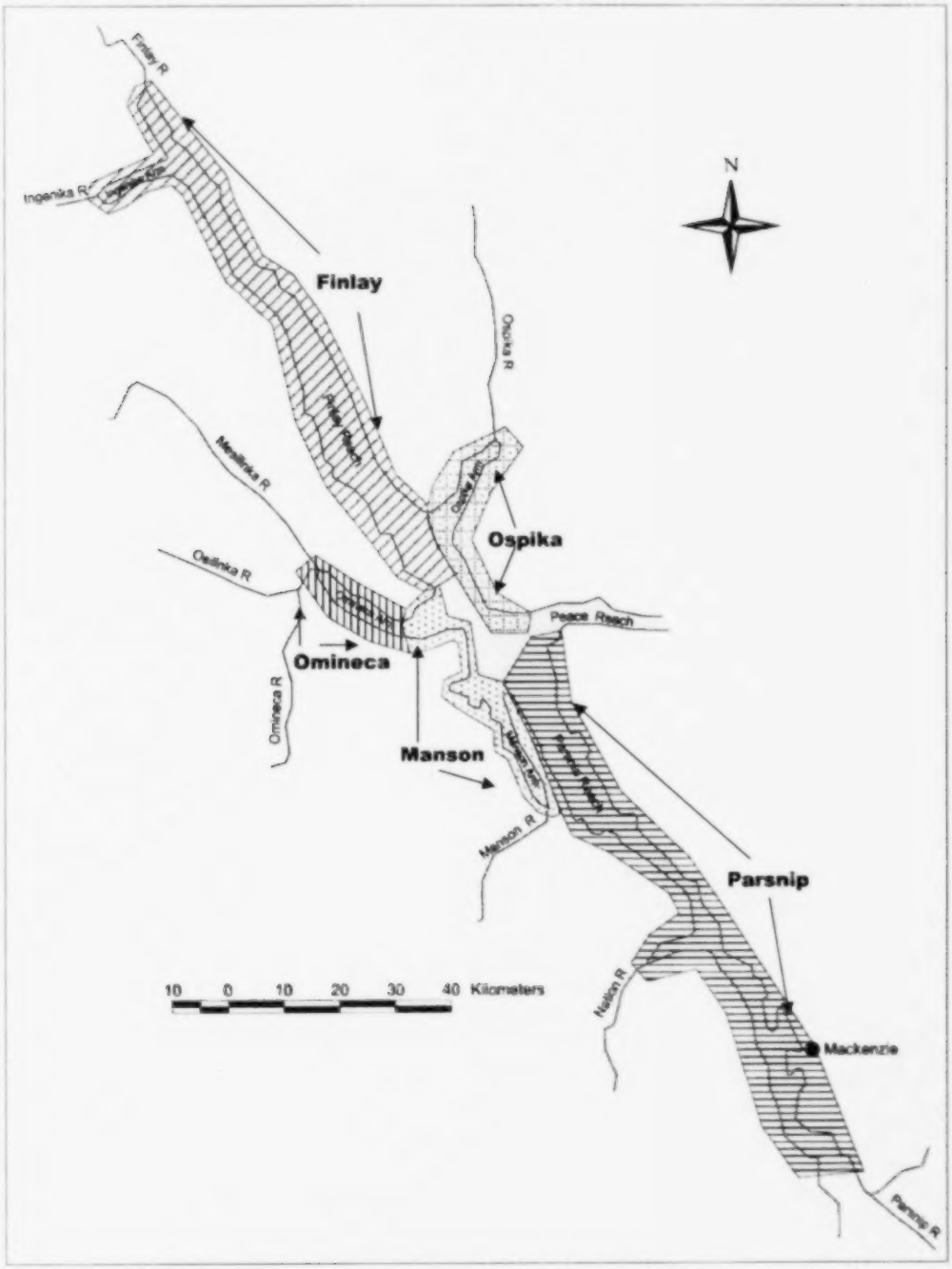


Figure 2. Delineation of the 5 geographic regions within the surveyed area, Finlay and Parsnip Reaches, Williston Reservoir.

Table 4. Definitions of nest site status for their classification between survey periods.

Code	Definition of nest site status
fa	Nest still present, but falling apart; nest was not considered to be present or available to a nesting osprey.
p	Nest present in same nest tree.
nf	Nest not present (e.g., fallen), but the nest tree was still present.
npfu	Nest not present, and its fate was unknown (e.g., could not determine if the nest tree or only the nest had fallen).
tf	Nest not present as the nest tree had fallen.

Nest site loss and gain were also examined based on their different positions within the cross-sectional profile of the study area. Due to the low numbers of nest sites in areas outside of the upper and lower inundation zones of the reservoir, nest sites from the remaining 5 positions (upland, upland shoreline, wetland inundated upper, wetland inundated lower, and wetland natural) were collapsed into a category henceforth referred to as "other".

A Chi-squared test was used to examine the loss of gross and occupied nests found in the upper and lower inundation zones between June 1997 and June 2002. This analysis compared the number of nests lost and the number of nests left remaining between these two time periods, and tested if nest site loss was dependent upon position in the reservoir. This analysis was only used for data between June 1997 and June 2002 due to the lack of reliability in data classification (1995 data) or sample size constraints (Sep 2002 data). Statistical significance was evaluated at α=0.05 level.

4.2.3 Clutch sizes

Clutch sizes (eggs per occupied nest) were calculated for each nest site in each year where data were available. A one-way analysis of variance was used to determine if any statistical difference in clutch size was observed among years. Statistical significance was evaluated at α=0.05 level.

5.0 RESULTS

5.1 Nest site distribution between and within years

The gross and occupied osprey nests remained relatively constant between the three survey periods, 1995 to 2002 (Table 5). The gross nest sites ranged between 112 and 134 nest sites in any given year, and the number of occupied nests only differed by 4 nests (75 to 79 occupied nests) during the three survey periods. Over the 7-year period, there were 1.4 to 1.7 nests for every occupied nest site.

Table 5 Abundance of gross and occupied osprey nest sites in each region within the Williston Reservoir survey area for 1995, 1997 and 2002.

	1995				1997				2002			
	Gross nests		Occupied nests		Gross nests		Occupied nests		Gross nests		Occupied nests	
Region	N	%	N	%	N	%	N	%	N	%	N	%
Parsnip	21	18.8	16	20.3	24	17.9	16	20.5	30	24.6	18	24.0
Manson	52	46.4	37	46.8	58	43.3	33	42.3	39	31.1	21	28.0
Omineca	2	1.8	2	2.5	3	2.2	3	3.8	4	3.3	3	4.0
Ospika	5	4.5	4	5.1	7	5.2	3	3.8	5	4.1	1	1.3
Finlay	32	28.6	20	25.3	42	31.3	23	29.5	45	36.9	32	42.7
TOTAL	112		79		134		78		123		75	

The distribution of nest sites within the different geographic regions, however, has changed markedly. There appears to be a shift in the distribution of nest sites from the Manson region to the Finlay region (Table 5, Figure 3). In 1995, the Manson region accounted for 46% (52 nests) of gross nests, but by June 2002 it accounted for only 31% (39 nests) of gross nests. Likewise, the proportion of occupied nests decreased from 47% (37 occupied nests) in 1995 to 28% (21 occupied nests) in June 2002. Conversely, gross nests increased in the Finlay region from 29% (32 nests) in 1995 to 37% (45 nests) in 2002. As well, the proportion of occupied nests has increased for the Finlay region from 25% (20 occupied nests) in 1995 to 43% (32 occupied nests) in 2002. Little change (<7%) has occurred in the other regions of the study area for both total nests and occupied nests.

Most nest sites (both gross and occupied) occurred within either the lower (IZL) or upper inundation (IZU) zones (Table 6, Figure 4). For each survey year, these zones accounted for over 80% of both the gross and occupied nest sites. All other positions in the survey area, by themselves, represented less than 8% of the gross and occupied nest sites. There appears to

be a trend towards both gross and occupied nest sites being positioned away from the IZL and into the IZU. From 1995 to 2002, the IZL component has declined from about 65% to approximately 50%, whereas the IZU component has increased from 25% to over 30%. There does not appear to be any noticeable trend in nest site placement for the other positions.

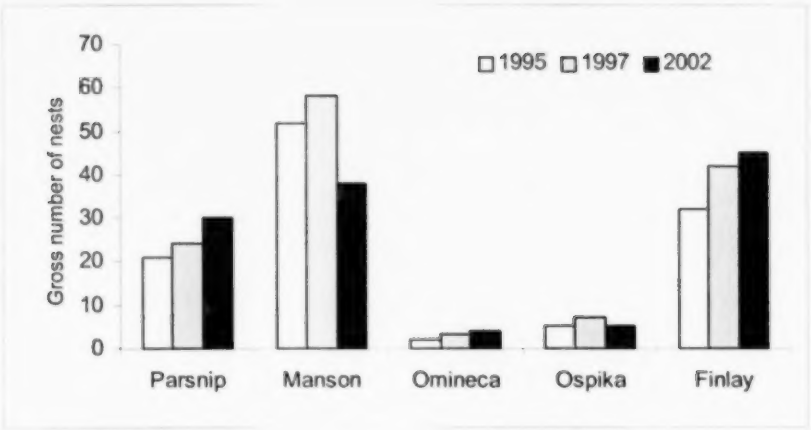
Table 6. Abundance of gross and occupied osprey nest sites, by nest site position[1], within the Williston Reservoir survey area for 1995, 1997 and 2002.

	1995				1997				2002			
	Gross nests		Occupied nests		Gross nests		Occupied nests		Gross nests		Occupied nests	
Position	N	%	N	%	N	%	N	%	N	%	N	%
IZL	72	64.3	52	65.8	73	54.5	47	60.3	61	49.2	38	50.7
IZU	29	25.9	20	25.3	39	29.1	17	21.8	38	31.1	26	34.7
U	3	2.7	2	2.5	8	6.0	4	5.1	9	7.4	1	1.3
US	3	2.7	1	1.3	5	3.7	2	2.6	5	4.1	4	5.3
WIL	2	1.8	1	1.3	3	2.2	3	3.8	5	4.1	2	2.7
WIU					1	0.7	1	1.3	1	0.8		
WN	3	2.7	3	3.8	5	3.7	4	5.1	4	3.3	4	5.3
TOTAL	112		79		134		78		123		75	

[1] IZL = lower inundation zone, IZU = upper inundation zone, U = upland, US = upland shoreline, WIL = wetland inundated lower, WIU = wetland inundated upper, and WN = wetland natural.

For the three main regions with sizeable numbers of nest sites (Manson, Finlay and Parsnip), the predominant nest site position varied between the IZU and IZL between regions, but was consistent across survey periods (Table 7). For both gross and occupied nest sites, the Manson (84-89%) and Parsnip (50-76%) regions had nest sites mainly in the IZL, whereas the Finlay region nest sites were mostly (52-65%) in the IZU. Other gross and occupied nest sites represented less than 32% of the nest sites in any given year in these three regions.

a) Gross nest sites



b) Occupied nest sites

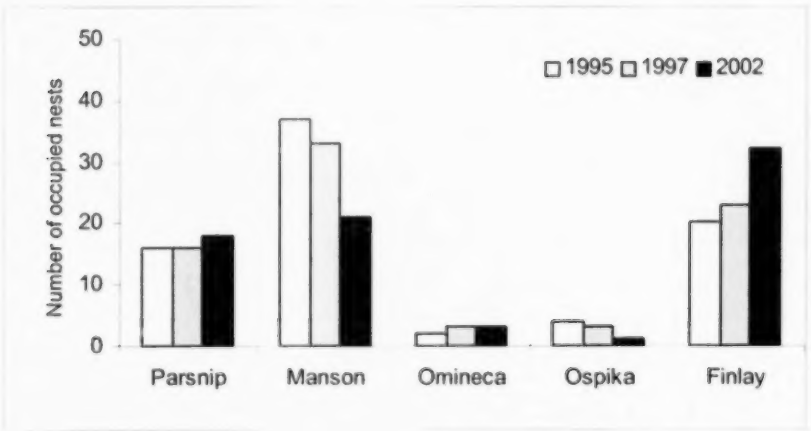
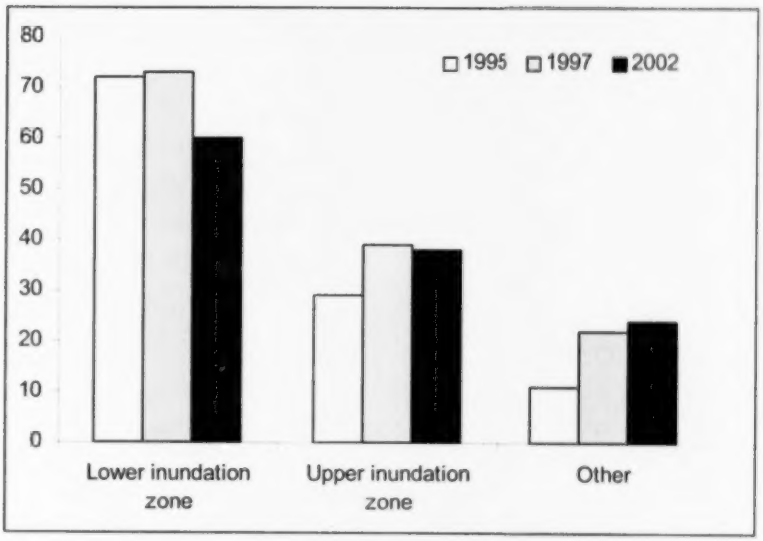


Figure 3. Abundance of (a) gross and (b) occupied nests sites in each region of the Williston Reservoir survey area for 1995, 1997 and 2002.

a) Gross nest sites



b) Occupied nest sites

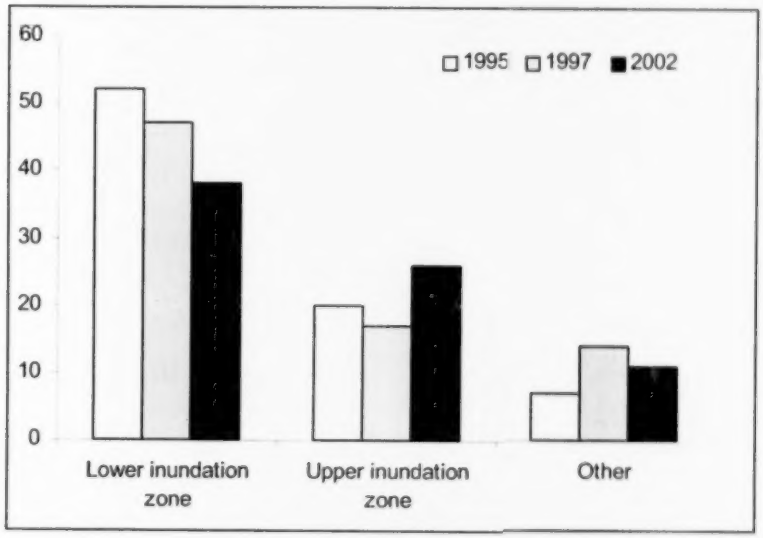


Figure 4. Abundance of (a) gross and (b) occupied osprey nest sites, by nest site position, within the Williston Reservoir survey area for 1995, 1997 and 2002. 'Other' includes nest sites in upland and wetland (natural and reservoir-influenced) positions.

Table 7. Abundance of gross and occupied osprey nest sites, by nest site position[1], in each region of the Williston Reservoir survey area for 1995, 1997 and 2002.

		1995				1997				2002			
		Gross nests		Occupied nests		Gross nests		Occupied nests		Gross nests		Occupied nests	
Region	Position	N	%	N	%	N	%	N	%	N	%	N	%
Parsnip	IZL	16	76.2	12	75.0	14	58.3	10	62.5	15	50.0	10	55.6
	IZU	2	9.5	2	12.5	4	16.7	1	6.3	6	20.0	4	22.2
	Other	3	14.3	2	12.5	6	25.0	5	31.3	9	30.0	4	22.2
	Total	21		16		24		16		30		18	
Manson	IZL	46	88.5	33	89.2	49	84.5	29	87.9	33	84.2	18	85.7
	IZU	6	11.5	4	10.8	8	13.8	3	9.1	6	15.8	3	14.3
	Other					1	1.7	1	3.0				
	Total	52		37		58		33		38		21	
Omineca	IZL	2	100	2	100	3	100	3	100	4	100	3	100
	IZU												
	Other												
	Total	2		2		3		3		4		3	
Ospika	IZL	1	20.0	1	25.0	1	14.3			1	20.0	1	100
	IZU	1	20.0	1	25.0	1	14.3	1	33.3				
	Other	3	60.0	2	50.0	5	71.4	2	66.7	4	80.0		
	Total	5		4		7		3		5		1	
Finlay	IZL	7	21.9	4	20.0	6	14.3	5	21.7	8	17.8	6	18.8
	IZU	20	62.5	13	65.0	26	61.9	12	52.2	26	57.8	19	59.4
	Other	5	15.6	3	15.0	10	23.8	6	26.1	11	24.4	7	21.9
	Total	32		20		42		23		45		32	
TOTAL		112		79		134		78		123		75	

[1] IZU = upper inundation zone, IZL = lower inundation zone, Other = upland, upland shoreline, wetland inundated lower, wetland inundated upper, and wetland natural.

5.2 Nest site attrition and gain

5.2.1 Gross nest sites June 1997 to June 2002 (5 year)

Only 42 gross nest sites (31%) located in June 1997 persisted to June 2002 (Table 8). The majority were located in the lower inundation zone of the Manson region.

Table 8. Distribution of gross nest sites, by nest site postion[1] and region, that persisted between June 1997 and June 2002.

	IZL		IZU		Other		Total	
Region	N	%[2]	N	%[2]	N	%[2]	N	%
Parsnip	7	17	2	5	3	7	12	29
Manson	15	36	2	5		0	17	40
Omineca	3	7		0		0	3	7
Ospika		0		0	3	7	3	7
Finlay	3	7	2	5	2	5	7	17
TOTAL	28	67	6	14	8	19	42	100

[1] IZU = upper inundation zone, IZL = lower inundation zone, Other = upland, upland shoreline, wetland inundated lower, wetland inundated upper, and wetland natural.
[2] Nests retained in each nest site position as a proportion of the total gross nest sites that persisted.

By June 2002, 69% (92 of 134) of the 1997 gross nest sites had been lost (Table 9). The majority of these nests were lost from the Manson and Finlay regions, 41 (45%) and 35 (38%) nest sites respectively. Within a region, between 50% and 83% of their 1997 nest sites were lost by 2002, except for the Omineca region that did not lose one of its three nest sites. During the same time period, 80 new nest sites were added, with most nest sites being added in the Finlay (48%), Manson (26%) and Parsnip (22%) regions. Consequently, there was only a 9% net loss (12 nest sites) of gross nest sites over the 5-year period.

Forty-five (49%) of the 92 gross nest sites that had been lost by 2002 were located in the IZL, with the Manson region accounting for 34 nests (Table 10). Thirty-three (36%) gross nest sites, mainly from the Finlay region, were lost from the IZU, (Table 10). Almost 85% of the nests found in the IZU in June 1997 were no longer present in June 2002. This exceeded the 62-64% of the nests that were lost from the IZL and other positions during the same period. Results from the chi-squared test indicated that nest loss was dependent upon their position in the reservoir as significantly more nests were lost in the IZU compared to the IZL ($\chi^2_{(0.05,1)} = 3.84 < \chi^2 = 5.31 < \chi^2_{(0.01,1)} = 6.635$).

Table 9. Attrition and gain of gross osprey nest sites in the 5 regions of the Williston Reservoir survey area between June 1997 and June 2002.

Region	Nest sites present in 1997 (N)	Nest sites lost by 2002		Nest sites lost per region (%)	Origin of June 2002 nest sites		
					1997 nest sites (N)	New nest sites added	
		N	%			N	%
Parsnip	24	12	13.0	50.0	12	18	22.5
Manson	58	41	44.6	70.7	17	21	26.3
Omineca	3				3	1	1.3
Ospika	7	4	4.3	57.1	3	2	2.5
Finlay	42	35	38.0	83.3	7	38	47.5
TOTAL	134	92	100		42	80	100

Table 10. Attrition and gain, by nest site position[1] and region, of gross osprey nest sites between June 1997 and June 2002.

Region	Gross nest sites lost (N=92)						Gross nest sites gained (N=80)					
	IZL		IZU		Other		IZL		IZU		Other	
	N	%[2]	N	%[2]	N	%[2]	N	%[3]	N	%[3]	N	%[3]
Parsnip	7	9.6	2	5.1	3	13.6	8	10.0	4	5.0	6	7.5
Manson	34	46.6	6	15.4	1	4.5	17	21.3	4	5.0		
Omineca							1	1.3				
Ospika	1	1.4	1	2.6	2	9.1	1	1.3			1	1.3
Finlay	3	4.1	24	61.5	8	36.4	5	6.3	24	30.0	9	11.3
TOTAL	45	61.6	33	84.6	14	63.6	32	40.0	32	40.0	16	20.0

[1] IZU = upper inundation zone, IZL = lower inundation zone, Other = upland, upland shoreline, wetland inundated lower, wetland inundated upper, and wetland natural.
[2] Nests lost in each region as a proportion of the total 1997 gross nest sites for their respective site position (IZL_{total} = 73, IZU_{total} = 39, $Other_{total}$ = 22).
[3] Nests gained in each region as a proportion of the total new 2002 gross nest sites (n = 80).

Gross nest sites that were gained by June 2002 were established equally (40%) in both the IZL and IZU positions (Table 10). New nest sites were established predominantly in the Finlay IZU (30%) and Manson IZL (21%) areas.

5.2.2 Occupied nest sites June 1997 to June 2002 (5 year)

Twenty-three (29%) of the 78 nest sites that were occupied by ospreys in June 1997 persisted to June 2002 (Table 11). The majority (78%) of these nest sites were situated in the IZL, primarily in the Parsnip and Manson regions. None of the occupied nest sites that were

located in the IZU during the June 1997 survey were still present by June 2002. Of the 23 nest sites that were occupied in June 1997 and persisted to June 2002, 13 nests (56%) were again occupied by ospreys in June 2002 (Table 12).

Table 11. Distribution of nest sites, by nest site postion[1] and region, that were occupied by ospreys in June 1997 and persisted to June 2002.

	IZL		IZU		Other		Total	
Region	N	%[2]	N	%[2]	N	%[2]	N	%
Parsnip	5	22		0	3	13	8	35
Manson	8	35		0		0	8	35
Omineca	3	13		0		0	3	13
Ospika		0		0	1	4	1	4
Finlay	2	9		0	1	4	3	13
TOTAL	18	78	0	0	5	22	23	100

[1] IZU = upper inundation zone, IZL = lower inundation zone, Other = upland, upland shoreline, wetland inundated lower, wetland inundated upper, and wetland natural.
[2] Nests retained in each nest site position as a proportion of the total gross nest sites that persisted.

Table 12. Attrition and gain of occupied osprey nest sites in the 5 regions of the Williston Reservoir survey area between June 1997 and June 2002[1].

					Nest sites that persisted from 1997-2002				
	Occupied nests in	Occupied nests[2] lost by 2002		Occupied nests[2] lost per region	Occupied 1997, unoccupied 2002	Unoccupied 1997, occupied 2002	Occupied 1997 & 2002	New occupied nest sites added	
Region	1997 (N)	N	%	(%)	(N)	(N)	(N)	N	%
Parsnip	16	8	14.5	50.0	5	4	3	11	22.4
Manson	33	25	45.5	75.8	2	6	6	9	18.4
Omineca	3				1		2	1	2.0
Ospika	3	2	3.6	66.7	1			1	2.0
Finlay	23	20	36.4	87.0	1	3	2	27	55.1
TOTAL	78	55	100		10	13	13	49	100

[1] There were 75 occupied osprey nests located in June 2002.
[2] Nest sites were occupied by ospreys in June 1997, but in June 2002 the nests or nest trees were no longer present .

Fifty-five (71%) of the 78 nests that were occupied in June 1997 were not present in June 2002 (Table 12). The Manson and Finlay regions accounted for over 80% of those that were no longer present. Similar to the loss of gross nest sites, 50-87% of the 1997 occupied nest sites were lost in each region by 2002. The loss of 1997 occupied nest sites was almost completely compensated for by the establishment of 49 new occupied nest sites, with most

new nest sites being built in the Finlay (55%) region (Table 12). In 2002, ospreys also occupied 13 nests that were present but unoccupied (i.e., gross nest site) in 1997.

Reflective of the gross nest sites, none of the occupied nest sites located in the IZU during the June 1997 survey were present in June 2002, and about 62-64% were lost in the IZL and other position category (Table 13). Significantly more occupied nest sites were lost in the IZU compared to the IZL ($\chi^2_{(0.01,1)} = 6.635 < \chi^2 = 7.26 < \chi^2_{(0.001,1)} = 10.828$). Similarly, 80% of the new occupied nest sites were established almost evenly within each the IZU and IZL, with sites in the Finlay IZU contributing the largest component (37%; Table 13).

Table 13. Attrition and gain, by nest site position[1] and region, of occupied osprey nest sites in the Williston Reservoir survey area between June 1997 and June 2002.

	Occupied nest sites lost (N=55)						Occupied nest sites gained (N=49)					
	IZL		IZU		Other		IZL		IZU		Other	
Region	N	%[2]	N	%[2]	N	%[2]	N	%[3]	N	%[3]	N	%[3]
Parsnip	5	10.6	1	5.9	2	14.3	5	10.2	2	4.1	4	8.2
Manson	21	44.7	3	17.6	1	7.1	8	16.3	1	2.0		
Omineca							1	2.0				
Ospika			1	5.9	1	7.1	1	2.0				
Finlay	3	6.4	12	70.6	5	35.7	3	6.1	18	36.7	6	12.2
TOTAL	29	61.7	17	100	9	64.3	18	36.7	21	42.9	10	20.4

[1] IZU = upper inundation zone, IZL = lower inundation zone, Other = upland, upland shoreline, wetland inundated lower, wetland inundated upper, and wetland natural.
[2] Nests lost in each region as a proportion of the total 1997 occupied nest sites for their respective site position ($IZL_{total} = 47$, $IZU_{total} = 17$, $Other_{total} = 14$).
[3] Nests gained in each region as a proportion of the total new 2002 occupied nest sites (n = 49).

5.2.3 Gross nest sites April to June 2002 (within year)

Eleven (10%) of the 113 gross nest sites recorded in April 2002 were lost by the June 2002 survey (Table 14). The majority (N=7) of these nest sites were lost in the Manson region. The Manson region, as well, had the highest within-region loss (16%) during the period.

Offsetting these losses, 21 new gross nest sites were added, with the majority (62%) of these nests being established in the Finlay region. Thirteen (62%) of the new nest sites were occupied by ospreys on the June survey. Two nest sites that were deemed unavailable (i.e., falling apart) in April had also been rebuilt by June: 1 nest was occupied, the other was not.

Table 14. Attrition and gain of gross osprey nest sites in the 5 regions of the Williston Reservoir survey area between April and June 2002.

Region	Nest sites present in April (N)	Nest sites lost by June		Nest sites lost per region (%)	New nest sites added	
		N	%		N	%
Parsnip	27	1	9.1	3.7	4	19.0
Manson	43	7	63.6	16.3	3	14.3
Omineca	3				1	4.8
Ospika	5					
Finlay	35	3	27.3	8.6	13	61.9
TOTAL	113	11	100		21	100

Based on nest site position, most (8 of 11) of the nest sites lost between April and June 2002 had been located in the IZL, mainly in the Manson region (Table 15). Half (11 of 21) of the gross nest sites gained over this 2-month period were established in the IZU, primarily in the Finlay region.

Table 15. Attrition and gain, by nest site position[1] and region, of gross osprey nest sites in the Williston Reservoir survey area between April and June 2002.

Region	Gross nest sites lost (N=11)						Gross nest sites gained (N=21)					
	IZL		IZU		Other		IZL		IZU		Other	
	N	%[2]	N	%[2]	N	%[2]	N	%[3]	N	%[3]	N	%[3]
Parsnip			1	3.6			2	9.5	2	9.5		
Manson	6	9.5			1	4.5	3	14.3				
Omineca							1	4.8				
Ospika												
Finlay	2	3.2			1	4.5			9	42.9	4	19.0
TOTAL	8	12.7	1	3.6	2	9.1	6	28.6	11	52.4	4	19.0

[1] IZU = upper inundation zone, IZL = lower inundation zone, Other = upland, upland shoreline, wetland inundated lower, wetland inundated upper, and wetland natural.

[2] Nests lost in each region as a proportion of the total April 2002 gross nest sites for their respective site position (IZL_{total} = 63, IZU_{total} = 28, $Other_{total}$ = 22).

[3] Nests gained in each region as a proportion of the total new June 2002 gross nest sites (N = 21).

5.2.4 Gross and occupied nest sites June to September 2002 (high water)

Fifty-seven gross nest sites in the Manson ($n_{s,m}$=38), Parsnip ($n_{s,M}$=16) and Omineca ($n_{s,o}$=3) regions were revisited in September 2002, principally to assess if any of these potentially vulnerable nest sites had been affected by the reservoir's full-pool water levels. Nine (16%) nest sites were no longer present, all but one was in the Manson region (Table 16 and 17). During this survey, we also observed 3 new nest sites in the IZL of the Manson region; none of these new nests showed any sign of being occupied or active during the September survey.

Table 16. Attrition and gain of selected gross osprey nest sites in the Manson, Omineca and Parsnip regions of the Williston Reservoir survey area between June and September 2002.

Region	Nest sites present in June (n_s[1])	Nest sites lost by September		Nest sites lost per region (%)	New nest sites added	
		N	%		N	%
Parsnip	16	1	11.1	6.3		
Manson	38	8	88.9	21.1	3	100
Omineca	3					
TOTAL	57	9	100		3	100

[1] n_s = subset of June 2002 gross nest sites from the Parsnip, Manson and Omineca regions.

Table17. Attrition and gain, by nest site position[1] and region, of selected gross osprey nest sites in the Parsnip, Manson and Omineca regions of the Williston Reservoir survey area between June and September 2002.

Region	Gross nest sites lost (n=9)						Gross nest sites gained (n=3)					
	IZL		IZU		Other		IZL		IZU		Other	
	N	%[2]	N	%[2]	N	%[2]	N	%[3]	N	%[3]	N	%[3]
Parsnip			1	10.0								
Manson	7	16.3	1	10.0			3	100				
Omineca												
TOTAL	7	16.3	2	20.0			3	100				

[1] IZU = upper inundation zone, IZL = lower inundation zone, Other = upland, upland shoreline, wetland inundated lower, wetland inundated upper, and wetland natural.

[2] Nests lost in each region as a proportion of the subset of June 2002 gross nest sites for their respective site position ($n_{s,IZL}$ = 43, $n_{s,IZU}$ = 10, $n_{s,Other}$ = 4).

[3] Nests gained in each region as a proportion of the total new June 2002 nest sites (N = 3).

Of the 35 occupied nest sites that were re-visited, only 2 nests were lost by the September survey: one had become flooded by the reservoir and the other nest was no longer in its nest tree. Both of these occupied nest sites were located in the IZL of the Manson region.

5.3 Nest fates

5.3.1 Gross and occupied nest sites June 1997 to June 2002 (5 year)

The fate of the 92 gross and 55 occupied nest sites that were lost between June 1997 and June 2002 was largely unknown (71-73%, Table 18). Because nest trees were often in areas where many other snags were present, it was difficult to determine if the nest had fallen from the nest tree, or if the nest tree had fallen.

Table 18. Fate of gross and occupied osprey nest sites within the Williston Reservoir survey area between June 1997 and June 2002.

	Gross nest sites		Occupied nest sites	
Nest site fate	N	%	N	%
Nest fallen apart	7	7.6	6	10.9
Nest flooded	4	4.3	3	5.5
Nest fallen out of tree	14	15.2	5	9.1
Fate unknown	65	70.7	40	72.7
Nest tree fallen	2	2.2	1	1.8
TOTAL	92		55	

5.3.2 Gross nest sites April to June 2002 (within year)

Eleven gross nest sites were lost between April and June 2002, with 6 nests having fallen apart (Table 19).

Table19 Fate of gross osprey nest sites within the Williston Reservoir survey area between April and June 2002.

	Gross nest sites	
Nest site fate	N	%
Nest fallen apart	6	54.5
Nest flooded	2	18.2
Nest fallen out of tree	1	9.1
Fate unknown		
Nest tree fallen	2	18.2
TOTAL	11	100

5.3.3 Gross and occupied nest sites June to September 2002 (high water)

During the September survey, 6 nests (one of which was occupied) were flooded (i.e., nest at or below the 671.3 m water level mark), two had fallen apart, and one nest (also occupied) had fallen from its nest tree. On 6 other occasions, nests that must have been completely flooded, or at least incurred some wave action, while the reservoir was at full pool showed no visible signs of significant structural degradation; water levels were at, or within 10 cm, of full pool for 18 days (11 Jul to 28 Jul 2002; BC Hydro, unpublished data).

5.4 Clutch sizes

Clutch sizes for occupied osprey nests identified during the 1995, 1997 and 2002 surveys ranged from 0 to 5 eggs per nest, with an average of 2.36 to 2.65 eggs per nest (Table 20). For occupied nests with eggs, 3 eggs per nest was most common (Figure 5). There was no significant difference in the clutch size among years ($F_{2,213} = 2.19$, $p = 0.11$).

Table 20. Clutch size data for occupied osprey nest sites within the Williston Reservoir survey area, June 1995[1], 1997[1] and 2002.

Year	Occupied nests (N)	Eggs per nest			
		Minimum	Maximum	Mean	Std. Error
1995	69	0	4	2.45	0.1
1997	71	0	4	2.65	0.08
2002	74[2]	0	5	2.36	0.11

[1] Data not consistent with values presented by Booth et al. (1999) for 1995 and Merkens et al. (1999) for 1997 due to nest site classification and inclusion differences.

[2] At one nest the number of eggs could not be counted because the resident female would not leave the nest.

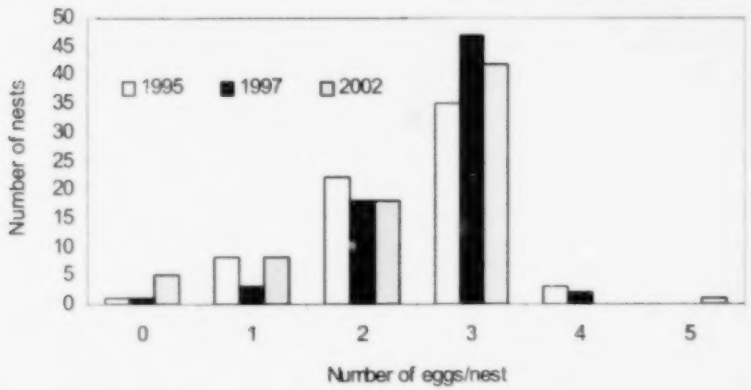


Figure 5. Distribution of the number of eggs recorded in each nest within the Williston Reservoir survey area for 1995, 1997 and 2002.

6.0 DISCUSSION

6.1 Nest site distribution

6.1.1 Analysis differences from previous years

As a result of our reclassification of nest sites according to their position (e.g., IZL, IZU, US), our analysis has yielded a different number of gross and occupied nest sites for 1995 and 1997 than what was reported by Booth et al. (1999) and Merkens et. al (1999) for those time periods. Also, some of the nest sites excluded from their 1995 and 1997 analyses have been included in our analyses. We included nest sites that were located further than 300 m from the forest-reservoir interface in our analyses in order to include low-lying areas that have been influenced by reservoir water levels since impoundment. In so doing, we were further able to examine the role of the fluctuating reservoir water levels on the distribution of osprey nest sites.

In addition to the position classification differences, the classification of nests into regions was also changed slightly. A portion of the Omineca Arm (east of Black Canyon) was included in the Manson region. This reclassification came about because of an increased knowledge of the functioning of the reservoir since the 1995 and 1997 surveys.

6.1.2 Williston osprey nesting population

The consistency in the number of occupied nest sites from 1995 to 2002 suggests that the osprey population around the Williston Reservoir is stable. This is further supported by the fact that clutch sizes remained consistent over the same time period. A more commonly used and more accurate predictor of osprey population stability, however, is the number of young produced per breeding pair per year (Henny and Wight 1969). Unfortunately, resources did not allow for the collection of these data in 2002. Consequently, we are not able to say with certainty that this population is truly stable.

6.1.3 Nest site distribution between years

The apparent shift in nest site distribution from the Manson region to the Finlay region illustrates the dynamic nature of this osprey population. It is unclear if the reduction in the number of occupied nest sites from the Manson region is cause for concern. Prior to 2002, the Manson region had had the greatest number and concentration of osprey nesting activity on the reservoir (Booth et al. 1999, Merkens et al. 1999). It was also an area that has

contributed substantially to the overall productivity of the osprey population, both in terms of young per occupied nest and young per successful nest . The change in distribution of more occupied nests in the Finlay region, an area of comparable productivity to the Manson region in 1995 and 1997 (Booth et al. 1999, Merkens et al. 1999), suggests that the productivity of the Williston Reservoir osprey population should remain constant. However, without productivity data from 2002, making this assumption may be unsubstantiated.

6.1.4 Individual nest sites: net changes

Ospreys inhabiting the Williston Reservoir area have concentrated their nesting activity in areas that are most affected by the reservoir (lower and upper inundation zones), sites that support extensive areas of dead and dying trees. Selection of these areas is not surprising as they provide suitable nesting habitat in close proximity to potential foraging sites (Postupalsky and Stackpole 1974, Piehler et al. 2002), and are protected to a large extent from terrestrial and avian predators such as Great Horned Owls (Poole 1989). Both gross and occupied nest sites show a trend that nests are being established with greater frequency in the upper inundation zone. This change in nest site positioning is likely more an artefact of nest site availability in the Manson (an area where nests are concentrated in the lower inundation zone) and Finlay (an area where nests are concentrated in the upper inundation zone) regions than an actual preference shift. It is unknown whether this geographic shift in nest-site selection is caused by possible changes in the nest site supply, food resources or other conditions within these two regions. It is likely that the number of potential nest trees in the lower inundation zone of the Manson region has decreased. However, it is not clear why the upper inundation zone of this area has not been colonised. It could be that this area does not provide adequate upper inundation zone nesting habitat, or it may be that the food resources of this area have declined. Unfortunately, no data presently exist to address either of these scenarios. Without a clearer understanding of what the potential nesting habitat supply – i.e., trees (dead or alive) with suitable places to establish an osprey nest – is in each region, other variables can not be ruled out. Of importance, though, is that while the nesting activity appears to be shifting from one region to another (Manson to Finlay), the majority of the nesting activity is still staying within the reservoir inundation area. As yet, there has not been a significant movement to upland areas where potential predators may have an increased negative affect on osprey productivity (Poole 1989).

6.2 Dynamics of nest sites

6.2.1 Overall nest loss and gain

Although the overall number of gross and occupied nest sites has remained relatively constant from 1995 to 2002 (N_{gross} = 112 to 134 nest sites, N_{occ} = 75 to 79 nests), individual nest sites prove to be fairly dynamic. For both gross and occupied nest sites, attrition rates were observed to be about 70% for the 5-year period June 1997 to June 2002. If we assume that these rates are more or less constant between years, the estimated annual attrition rate would be approximately 14% per year. These rates fall within the observed rates in other studies (Table 19). Our within-year (April to June) attrition rate of 10% is difficult to compare with our estimated annual rate and data from other studies as it does not encompass an entire calendar year.

Table 21. Annual loss of osprey nest sites from other areas of North America.

Area	Annual nest loss	Source
Florida	50-70%	Poole 1984[1]
New York	30-40%	Poole 1984[1]
California	30%	Airola and Schubert 1981[1]
Mexico	18-44%	Hammerstrom and Hammerstrom (unpublished)[1]
Montana	10-15%	Grover 1983[1]
Ontario	12%	Ewins 1995
Maryland	10%	Reese 1977[1]
Ontario	5%	Grier et al. 1977[1]

[1] From Poole 1989

During the 5-year and within-year time periods, the number of new nest sites that were established compensated for over 85% of the nest sites lost; only a small percentage of unoccupied nest sites were occupied by ospreys in the later survey. This further illustrates the dynamic nature of osprey nesting sites within the Williston Reservoir area. Some nests showed great resilience though, as a few nests had remained intact despite the fact they had been overtopped by water, or at least battered by waves, for multiple days in July and August.

The low incidence of nest-site loss between June and September 2002 illustrates that ospreys are generally selecting sites not directly affected by the reservoir water level. Some of the

substantial number of nest sites that had an unknown fate from June 1997 to June 2002, however, were likely lost due to reservoir flooding.

6.2.2 Nest site loss and gain within reservoir inundation zones

The significantly higher loss of nest sites in the upper inundation zone compared to the lower inundation zone between June 1997 and June 2002 for both gross and occupied nest sites is likely a result of different forces that act on the nest sites in these two positions. Nest sites in the lower inundation zone are more likely to be submerged than nests in the upper inundation zone. Consequently, their nest tree is less likely to be subjected to conditions that would affect their overall stability (e.g., wave action at roots [greater erosion], moist wood in aerobic conditions [increased presence of stem rot]).

Presently, the rate of loss in both the upper and lower inundation zones is more than offset by the number of new nests added each year. How long this trend will continue for the lower inundation zone is unclear, but it is obvious that eventually the availability of new nest sites in this reservoir position will cease. The upper inundation zone will likely continue to provide potential nest sites for some time to come. This is because new nest sites will become available as trees continue to die due to water level changes, and existing dead trees become more accessible to ospreys for nesting as their tops break off.

6.2.3 Long-term consequences

There appears to have been a change in the distribution of ospreys in a relatively short period of time (1997-2002). It is presently unclear what is driving this change. The shift from the Manson region to the Finlay region, and a shift from the lower inundation zone to the upper inundation zone may be driven by nest site availability, the abundance of food, a combination of both, or some other factor. What will happen to the osprey population over the long term is uncertain. Three hypothetical possibilities are presented below (Figure 6). Under these scenarios it is assumed that, due to stem loss and no recruitment, the number of nest sites in the lower inundation zone will decline and eventually reach zero. Similarly, since all trees that can possibly be affected by the reservoir's water levels have already been killed (i.e., the reservoir is not going to exceed full-pool levels that have already been attained), we expect recruitment of potential nest sites in the upper inundation zone to gradually decline. Based on field observations, however, we believe that the supply of potential nest sites is much greater in the upper inundation zone than in the lower inundation zone. And, although upper inundation zone nests appear to be lost at a quicker rate, it is unknown if it is the actual nest

or nest tree that is lost. Due to these factors, we expect that the complete loss of upper inundation zone nest sites will occur after all lower inundation zone nest sites are lost. The osprey population can react to these changes in at least one of three ways:

Outcome #1. The population remains stable by moving to the upper inundation zone, and then to the upland and wetland habitats adjacent to the reservoir.

Outcome #2. The number of ospreys decline and stabilise at a lower level, with a gradual decline in nest sites in the immediate vicinity of the shores of the reservoir.

Outcome #3. The number of ospreys crash as the number of nest sites falls below a certain threshold. The population then levels out as the remaining ospreys are confined to upland and wetland habitats adjacent to the reservoir.

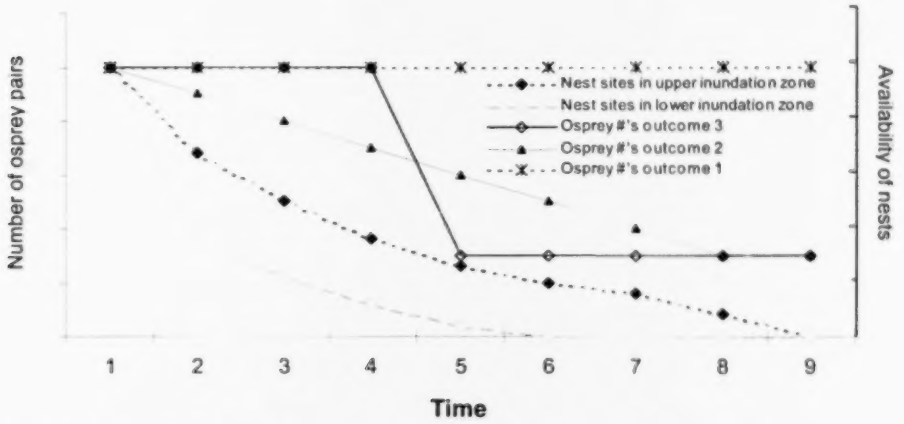


Figure 6. Hypothetical changes to osprey population in Williston Reservoir

It is very unlikely that ospreys will disappear from the Williston Reservoir, even if all nest sites are lost from the inundation zones. Ospreys will continue to nest adjacent to the reservoir in upland and non-reservoir influenced wetland habitats. It is, however, unlikely that these areas will support the current number of nests. Nesting areas with lower incidence of predation (e.g., areas where nest trees are surrounded by water) generally always support higher densities of nesting ospreys than nearby mainland or upland habitats even though locally all birds have access to the same foraging habitat (Poole 1989). Unless potential nest sites are provided in some fashion in the future, the osprey population will likely decline to a reduced number of nesting pairs. How and where nest sites could be provided is discussed in Section 6.3. If nest sites should be added, and how many nesting pairs or potential nest sites should be maintained in the Williston Reservoir area is a separate issue and is not addressed in this report.

6.3 Recommendations for future nest site comparison surveys

Determining the nest site status from one survey period to the next proved to be an arduous task. Although both GPS-derived locations and photographs were utilised, if either one was inaccurate, inconclusive, or incomplete then the identification of same nests were made much more difficult. For this reason, the nest site data from the 1995 survey were not used to assess the status of individual nest sites between 1995 and 1997.

Since it is not practical, or even logistically possible in many cases, to permanently mark every nest tree encountered (and access and read that specific mark in future years), the methodology used to identify individual trees and the position of a nest in the nest tree needs serious consideration. We feel that GPS-derived locations (with suitable accuracy, e.g., <15 m) and photographs still provide the best avenue to document the nest's location, but more standardised photographs need to be taken to help ease and authenticate a nest's identification.

Standardising the way photographs are taken can be a bit problematic, however, as several factors influence where and when a photograph can be taken while conducting the survey (e.g., position of the sun, nest obscurity, wind speed and direction for helicopter maneuverability). Nonetheless, photographs should be taken from at least two different distances (distant and close-up) and two different directions (e.g., 180° from each other), with the photograph direction being recorded. Distant photographs are needed to illustrate the surrounding area and juxtaposition of adjacent snags or other features, whereas close-up photographs are needed to determine the exact position of the nest in the tree.

7.0 NEST SITE ENHANCEMENT REVIEW AND RECOMMENDATIONS

7.1 Preamble

The following discussion of enhancing osprey nesting habitat was part of the overall PWFWCP osprey project for 2002. A literature review and discussions with osprey biologists was conducted to determine the nature of an enhancement trial that was planned for the fall of 2002. Subsequent to the submission of a draft document covering the review

and discussion findings, the enhancement trial was postponed. An updated version of this discussion paper is provided below.

7.2 Introduction

The provision of artificial structures for ospreys is a commonly used practice to provide nesting sites throughout Canada and the US (Poole 1989), parts of Mexico (Castellanos et al., 1995), and Europe (Meyburg et al. 1995, R. Dennis, Highland Foundation for Wildlife, personal communication). Artificial structures have been painstaking built by hand (R. Dennis, Highland Foundation for Wildlife, personal communication), erected with the assistance of heavy equipment on land and on ice (Ewins 1994), and dropped into suitable habitat from helicopters (Piehler et al. 1996). Artificial structures have been used successfully in a variety of different scenarios ranging from reintroduction programs whose goal was to re-establish local populations of breeding ospreys, to provision of nesting habitat for the benefit of human enjoyment. Reintroduction programs have often been accompanied by either an aggressive hacking program or a translocation initiative (Poole 1989). To summarise, platforms have accomplished three management objectives as outlined by Postupalsky 1978 –

- maintained pairs in suitable habitat, where natural nests might be deteriorating;
- maximized reproductive success and colonised new habitat, thereby allowing a population to reach its carrying capacity; and
- facilitated research by allowing easy access to nests.

While the use of artificial platforms has been extremely successful, there is a growing concern that the provision of artificial platforms is potentially making ospreys dependent upon this activity. Indeed, in several places ospreys are wholly dependent upon the maintenance of artificial platforms (Poole 1989).

What follows is a summary of the discussions held with osprey biologists from around the world as well as a summary of the literature on the use of artificial platforms. An artificial structure or platform, as defined here, is any man-made supporting structure that enables an osprey nest to be established on it.

7.3 Role of artificial nest sites in population dynamics: do nest sites limit ospreys?

Poole (1989) suggests that the availability of nest sites can regulate osprey populations in a density dependent manner. He states that as an osprey population grows the following can occur: nest sites tend to become scarce; new recruits are then forced to disperse farther from natal areas; age of first breeding is delayed; and individuals may settle in marginal habitat. Each of these factors can reduce the number of birds entering the population (Poole 1989). Likewise, there are numerous examples of where the provision of nest sites has increased local osprey populations. For example, over a 13-year period the use of artificial platforms has increased osprey populations by up to 650% in the 4-state Pittsburgh District watershed (included in this area are Ohio, Pennsylvania, New York, and West Virginia) from 1989 through 2001 (Piehler et al. 2002). Similarly, artificial structures (platforms, electrical poles, navigation lights) have led to the dramatic increase in a non-migratory population of ospreys in Baja California (Castellanos et al., 1995). Artificial nests have also been successfully used to encourage the re-colonisation of osprey populations in Scotland and England (R. Dennis, Highland Foundation for Wildlife, personal communication).

The increase in osprey populations in and around areas where artificial structures have been established is a result of an increase in local reproduction and local conditions (Poole 1989). Ospreys are known to have strong fidelity to natal areas: adults return to areas where they have previously bred, and nestlings return to areas where they were hatched (Poole 1989). This aspect of osprey biology, together with the general increase in productivity at artificial platforms accounts for the rapid expansion of osprey populations where artificial nest sites are abundant (Poole 1989). It must also be noted that nest site productivity and tenacity come from nest sites that occur in areas that afford good foraging opportunities (shallow water areas; P.J. Ewins, World Wildlife Fund, personal communication)

7.4 Platforms and productivity

How nesting platforms affect osprey productivity is somewhat unclear. There is considerable evidence that the productivity of ospreys nesting on artificial structures is higher than those pairs nesting on natural nests (Postupalsky 1978, Westall 1983, Reese 1977, Van Daele 1982 as cited in Poole 1989, Castellanos et al. 1995). There are also reports that there is no statistical difference in the productivity between natural and artificial sites (Postupalsky and Stackpole 1974, Flemming et al. 1991, Ewins 1995). Where differences do occur, the reason for the difference is a reduced incidence of nest failure at artificial nest sites (e.g., the total loss of young and eggs) due to reduced predation (Castellanos et al., 1995), and the reduced

incidence of nest loss due to high tides (Castellanos et al., 1995) and winds (Postupalsky and Stackpole 1974, Poole 1989). Like productivity, however, the evidence for reduced nest loss of artificial nests from wind is not universal. Ewins (1995) found no statistical difference in nest stability between artificial and natural nest sites. Unfortunately, there was no differentiation in these studies between artificial platforms that were surrounded by water or platforms along the shoreline. In a study where platforms were placed over the water and on shorelines, small sample sizes of shoreline nests prevented the comparison of productivity between platform locations (Piehler et al. 2002).

7.5 The use of artificial platforms and reservoirs

Ospreys readily colonise areas where water management activities provide both suitable foraging (e.g., shallow water fisheries) and nesting habitat (e.g., standing dead trees surrounded by water). Reservoirs in the eastern US that were initially colonised by ospreys experienced population declines as nest sites (emergent dead trees that were killed due to impoundment) began to rot and fall (Postupalsky and Stackpole 1974, Piehler et al. 2002). As the height and stability of standing trees declined, the incidence of nest failure increased to the point where intervention was deemed necessary.

7.6 Platform placement: how and where to place artificial nest structures?

While it is clear that ospreys will readily use artificial platforms, there is also evidence to suggest that the placement of platforms is extremely important. Poole (1989) states: "only where platforms are poorly sited, where safer over-water sites (channel markers and duck blinds) are available, or where pairs are already well established at natural sites do ospreys ignore nesting platforms". On reservoirs in the US, Postupalsky and Stackpole (1974) placed all platforms over water but in one of four specific places: 1) near existing, but unstable nests; 2) near recently fallen nests; 3) in suitable sections of the reservoir where no nests were located; or 4) in areas with a history of osprey nesting, but not occupied at the time.

In the Pittsburgh District, the U.S. Army Corps of Engineers (USACE) has placed platforms on reservoirs such that there are reservoirs with only shoreline platforms (including platforms mounted to other structures that may mimic shorelines, e.g., concrete dams), and reservoirs with both shoreline and in-water platforms (Piehler, K., personal communication). Their observation is that shoreline platforms are used less frequently than in-water platforms when adjusted for availability. Two of the 11 shoreline platforms and 16 of the 28 in-water platforms were used by ospreys in 2002. It is believed that ospreys select nests over water as

these nests afford them lower predation risk (P.J. Ewins, World Wildlife Fund, personal communication, K. Piehler, USACE, personal communication).

The USACE has also established artificial platforms on land. Where they have, platforms are typically placed greater than 100 m from woodland edge (often as much as 200 m) as platforms closer than 100 m from forest edges were rarely used. Having the platforms at least 100 m from a forest edge allows for both immediate and future occupancy issues: it provides an open setting that ospreys tend to prefer and it extends the time before the eventual overtopping of the nest tree by adjacent trees (K. Piehler, USACE, personal communication).

The topping of trees followed by the construction of an artificial platform has also been widely used. In Scotland, R. Dennis (Highland Foundation for Wildlife, personal communication) has used this technique extensively. Trees are topped along shorelines by tree climbers using brush saws, and then nests are built by hand using natural materials. This has been a very successful method of enhancing osprey populations, both in terms of increasing the number of nesting pairs and in increasing productivity, especially for young pairs breeding for the first time (R. Dennis, Highland Foundation for Wildlife, personal communication). The USACE has also topped trees and placed platforms on top on 4 occasions in the Pittsburgh District. There was, however, no use of these platforms by ospreys. If topping trees is to be used, the choice of the tree to be used is the most important consideration. It is recommended that super-canopy (veteran) or lone trees be topped (M. Martel, University of Minnesota, personal communication), and that the tree be girdled to prevent lower limbs from interfering with the nest platform (K. Piehler, USACE, personal communication). R. Dennis (Highland Foundation for Wildlife, personal communication) and Poole (1989) do not recommend girdling as non-girdled trees stand longer.

7.7 Methods of platform placement

Most artificial nesting programs utilise utility poles with a platform attached. These structures are placed in pre-dug holes by a utility truck equipped with an auger. Placement occurs outside the breeding season, often in winter. Trucks are driven onto the ice and holes are bored through the ice. The platform is then placed into the hole. In some cases, small tripods or quadrapods are manually positioned through the ice (Ewins 1995). Platforms have also been lowered by helicopter into pre-dug holes (1.7 m in depth) that were then vertically

aligned, and back filled with concrete (K. Piehler, USACE, personal communication). These holes were dug by hand during lower water levels.

The provision of artificial nesting sites has also been achieved by dropping bottom-sharpened utility poles, with their platforms attached, from helicopters into suitable substrate (Figures 7 a, b; Piehler et al. 1996). This technique has been proven to be difficult to employ successfully, however, due to problems associated with rotor wash and site conditions; areas need to have water depths of <1 m deep at the time of positioning (K. Piehler, USACE, personal communication). Nest poles with platforms are dropped from about 40 m above the ground, with an ideal placement resulting in at least 1.5 m of the pole penetrating into the substrate, with silt and clay substrates being best . There has been about a 50% success rate in getting the structure to lodge effectively. Where ice is deemed to be a problem, other structures are used to protect the nest pole; rocks are typically piled at the base of the pole to deflect ice away (K. Piehler, USACE, personal communication). To avoid contamination of personnel and water, pentachlorophenol-treated poles are now being coated with urethane or shellac prior to installation (K. Piehler, USACE, personal communication). Poole (1989) and M. Martel (University of Minnesota, personal communication) advocate the use of smaller, lighter poles and platforms (e.g., old aluminium irrigation pipes) to minimise costs as smaller structures can be erected by hand, or with limited and less-costly equipment.

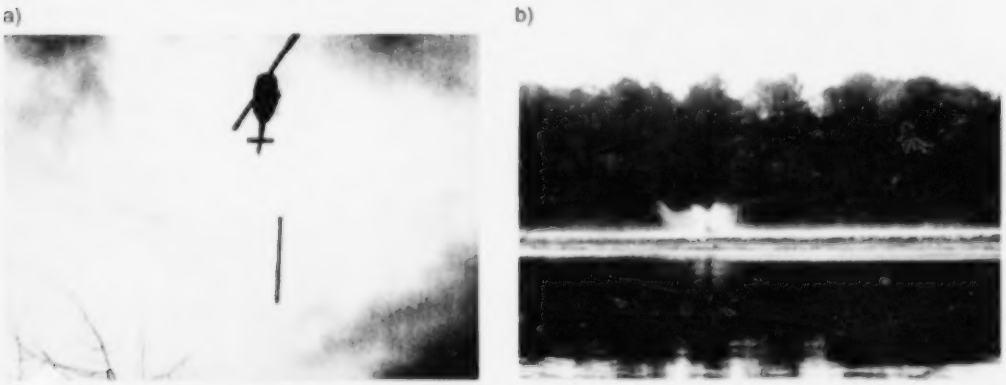


Figure 7 a, b. Establishment of osprey nesting structure, with platform attached, using a helicopter: a) helicopter carrying structure, and b) nesting structure as it enters the water after being released from the helicopter (courtesy of K. Piehler, USACE).

Regardless of the method used, it is widely believed that it is important to place sticks and other potential nesting material (e.g., moss) on the platform in order to entice birds to use the nest. It is believed that evidence of previous nesting activity may be a key to future

occupancy (M. Martel, University of Minnesota, personal communication, R. Dennis, Highland Foundation for Wildlife, personal communication).

7.8 Osprey nest enhancement and the Williston Reservoir

Our data indicate that most of the nesting activity takes place on snags in the inundation zones of the reservoir, often in places where nests are surrounded by water for the entire breeding period. If Poole's (1989) assertions are correct – recall ospreys may ignore platforms where safer over-water sites are available – then the provision of nest sites in any position other than over water will likely result in the non-use of these platforms. The experience of K. Piehler (USACE, personal communication), who works exclusively on reservoirs in the eastern US, supports this notion. He suggests that to install anything but a platform over the water will likely result in the platform being ignored. However, according to the experience from Scotland, ospreys can be lured into sites if the right tree is selected and a nest is carefully constructed (R. Dennis, Highland Foundation for Wildlife, personal communication).

One of the main potential constraints of establishing over-water platforms within the Williston Reservoir inundation zone is the large fluctuations in the water-level that the reservoir can experience each year (up to 17 m under normal operating conditions). Similar fluctuations encountered by the USACE at some reservoirs in the eastern US have necessitated the placement of some nesting platforms close to shore because water depths at their reservoirs generally increase quickly as distance from the shore increases. However, since the main goal in their program is to provide the best habitat conditions during the nesting season, they target placement sites that ensure structures are surrounded by water during this period, and try to maximise the platform height above the water (K. Piehler, USACE, personal communication).

Prior to conducting any human-intervention activities, the following points should be addressed, or at least considered:

1. Determine the exact objective of any enhancement activity. Is it for mitigation of nest site attrition, for expansion of the local (regional) or overall osprey population, or for an enhancement trial to see if and what artificial structures will be used in the Williston Reservoir area? These are very different objectives that will likely require different techniques and/or different types of data that may, or may not be available.

2. Determine the minimum number of gross and/or occupied nest sites that are desired to be maintained in the Williston Reservoir area, and/or a given region. This is required regardless if the objective is mitigation or expansion.

3. Determine what platform and supporting structures would work best in the Williston Reservoir area. Discuss options with other biologists that study or deal with ospreys, and in particular those who work on reservoirs.

4. Consult with the PWFWCP and other fisheries biologists regarding the availability of food resources throughout, or in certain areas, of the reservoir; this is paramount regardless of the nature of the enhancement.

5. Place artificial platforms where ospreys will have the greatest potential to be utilised, thus taking into consideration the nesting fidelity of ospreys and their reliance on fish as a food source (e.g., over-water sites in shallow water areas). Most of the Peace Arm and large sections of the Finlay and Parsnip Reaches did not have nests during any one of the three survey periods. Therefore, it must be determined if nest sites, rather than some other factor, are limiting in these areas.

6. Identify key areas where enhancement activities can be more easily conducted (e.g., large shallow areas) and where fish are more vulnerable to osprey predation (e.g., shallow and clear water areas). The availability of accurate bathymetric maps of the reservoir inundation area would greatly facilitate the planning and execution of this task.

7. Investigate the feasibility of installing over-water platforms in the Williston Reservoir from an engineering and logistical perspective.

8. Assess the cost-benefit of the different enhancement techniques, i.e., what method provides the greatest osprey productivity (fledglings, not just the most nesting pairs) for the least amount of funding.

9. If over-water nest sites are to be established, conduct activities in the spring when reservoir levels are lowest so that structures can be established as low in the reservoir inundation zone as possible.

8.0 CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The number of occupied nest sites and the productivity, as estimated by clutch size, for the Williston osprey population has changed little between 1995 and 2002. These observations suggest that, although there is a relatively dynamic nest site system occurring, this population is stable at present. However, with the apparent shift in nest site positioning to the upper inundation zone of the Finlay region, it is unknown if the same number of occupied nests are maintaining the same level of osprey productivity.

If the objective for the Williston osprey population is to maintain them at their 1995-2002 level, there is a need to continue monitoring their status; a 5-year return interval should be sufficient unless future surveys prove otherwise. And, to ensure that the geographic change in the occupied nest sites has no significant detrimental affect on the population, it would be prudent to conduct a productivity assessment during at least the next couple of survey periods.

Should any mitigative or expansion enhancement activities be conducted, over-water nest sites should be utilised if possible.

9.0 ACKNOWLEDGEMENTS

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